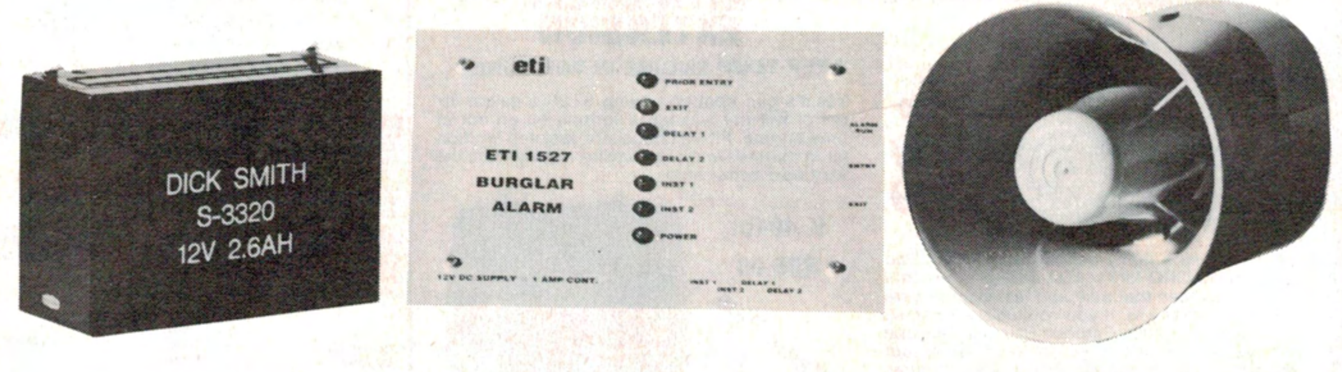
HOME BURGLAR ALARM MODULE

Part 1

Having to pay out a lot of money for an expensive home burglar alarm control could leave you feeling . . . er . . . robbed. With this simple alarm module it will cost you precious little to set up a comprehensive alarm system.

Robert Irwin



BURGLARY HAS, in recent times, become an all too common fact of life. City and suburban homes have become a favourite target for the break and enter thief. It is probably a safe bet that at least half our readers have come home from work or a night out somewhere only to find that their house has been broken into and their valuable and often personal possessions have been stolen.

A lot of people say that the worst aspect of a burglary is the feeling of violation, often much more traumatic than the actual loss suffered. The saddest thing is that most people still cling to that old adage "it doesn't matter what you do, if they want to get in they will".

While it is true that even the most sophisticated and expensive alarm system can be circumvented by very clever professional thieves, the statistics show that the majority of break and enters are done by rather clumsy amateurs who would probably have been put off by even the most rudimentary security measures.

The ETI-1527 burglar alarm module was developed from a design by Dick Smith Electronics and is intended to be the control centre for a comprehensive low cost burglar alarm system which includes many features found only in the much more expensive commercial units.

The cost of having a burglar alarm installed in an average home can range from around $500 to $2000 or more. With the ETI-1527 module an average home can be protected for about $100 or so depending on the type and number of sensors used. This board can form the basis of burglar alarm systems which can be as simple or complicated as you like.

Design details

The alarm has four sectors, that is, four inputs, which allow four separate alarm circuits to be wired up. Each of these circuits can contain a number of sensors. This will allow plenty of flexibility in the design of a sensing system for your particular needs. The types of sensors available and the installation of sensors will be covered in detail in later sections of this article. For now, let us examine the board itself.

The inputs are designed to be loaded by a 22k load resistor. Either shorting this resistor out or open circuiting the input will cause an alarm condition to be generated. This means that both N/O and N/C sensors can be used on the same input.

The use of four inputs allows the premises you are tyring to protect to be divided up into four sectors which can then be treated as separate circuits and wired accordingly.

Two of the sectors are provided with an entry delay and these can be used for the front and back doors to allow you to enter the premises without setting off the alarm immediately. The other two sectors are triggered straight away if a sensor is disturbed.

Apart from entry and exit delays the circuit also provides for an adjustable alarm run time. This allows you to set the time the siren or bell sounds after the alarm is triggered. After the alarm has sounded for this preset time the circuit will automatically re-arm itself. If the input which triggered the alarm in the first place is still active then the

HOW IT WORKS — ETI-1527

The circuit contains four input points. To ensure freedom from RF induction in the lines going out to the sensors two capacitors are paralleled up across the input terminals. A ceramic and a greencap were used in tandem to provide adequate suppression at all frequencies. The inputs are all identical and are connected to the inputs of four window comparators formed by the op-amps of IC1 and IC2. Each window comparator is made up from a pair of op-amps.

The threshold levels for the comparators is set by a resistive divider network formed by R5, R6 and R7. The voltage at the junction of R7 and R6 is 7.3 V and the voltage at the junction of R5 and R6 is 4.7 V. These are the upper and lower threshold voltages of the comparator respectively.

For the input of the alarm to be in the sealed state the input to the comparators must lie between the threshold voltages. This is accomplished with two 22k resistors. Each input has a 22k resistor connected between the input to the comparator and the positive supply rail (R1, R2, R3, R4). The external load resistor (not shown in the circuit diagram) is then used to connect from the comparator input to ground thus creating a voltage divider which holds the input at 6 V. If the load resistor is shorted out then the voltage will swing towards ground. If the resistor is open circuited then the voltage will swing to the positive rail. In either case a threshold will be exceeded causing the output of one or other of the op-amps in the window comparator to swing high. The diode pairs D1 and D2, D3 and D4, D5 and D6, D7 and D8, are used to OR the outputs of the op-amp pairs.

The output from the diodes is fed, via a capacitor, to one input of the flip-flops formed from pairs of cross-coupled NOR gates. The action of the capacitors is to provide the lock-out function but more will be said about this later. The remaining input on each of the flip-flops is tied via R16 and RV1 to ground. These resistors along with C13 provide the exit delay function.

At turn on the capacitor will initially be discharged and will therefore have no voltage drop across it. The voltage at the junction of C13 and R16 will then initially be pulled up to the positive rail. This forces the output of the flip-flops low regardless of the state of the input circuitry thus disabling the alarm triggering circuitry. As C13 charges, the voltage at R16 will fall. When it falls below the switching point of the CMOS (around 6 V) the output of the flip-flops will be dependent on the input from the comparators and thus the circuit will be in the armed state. The time taken for C13 to charge will be dependent on the setting of RV1 and thus the exit delay can be varied by varying RV1.

IC5a forms an inverter to drive the exit delay LED which is turned on while the exit delay is active. While the exit delay is active the lock out facility can operate. If a particular input is in the sealed state initially then the output of the comparator for that input will be low and therefore the output from the flip-flop which is connected to the appropriate sector LED will be high and the LED will be off.

If, however, an input is unsealed in the exit period, the output from the corresponding comparator will be high. Since the coupling capacitors (C9, C10, C11 and C12) are initially discharged the voltage at the input of the flip-flops will be high also. This will cause the appropriate sector LED to light. The coupling caps will charge through the 470k resistors and the voltage will drop. When the voltage drops past the switching point of the CMOS the LED will go off. The input then looks sealed to the flip-flops and the alarm can then be armed without the unsealed input causing it to trigger. This sector will then be locked out until it is sealed.

The remaining gating circuitry is dedicated to the alarm triggering logic. The inputs are divided up into two instant trigger inputs and two delayed trigger inputs. The outputs of the flip-flops for the instant inputs are ORed together by D9 and D10 and fed to one input of a NOR gate, IC5b. The delayed input trigger signals are ORed by D11 and D12 and are then fed via R26 and RV2 to a capacitor, C14. When a delay input is triggered the output of the appropriate flip-flop goes high and C14 will begin to charge.

The time taken to charge depends on the setting of RV2. The positive side of C14 is connected to the other input of the NOR gate, IC5b. This creates a time delay from when the input is triggered until the capacitor charges enough to switch the NOR gate.

Diode D14 provides a discharge path for C14 via R18. When the alarm is triggered the output of IC6c goes high. This provides a pulse which triggers the latch formed by IC6a and b. This has three effects. Firstly, the output of the inverter formed by IC6d goes low which turns on the siren and bell circuitry. Secondly, the output from IC6b goes low and resets the input flip-flops. The third thing that happens is that the latch formed by IC5c and d is set which causes the prior entry LED to light. This latch is only reset at power up by C21 and R29.

When the alarm is triggered the output of IC6a goes high. This causes C22 to begin charging through R28 and RV3. When the cap voltage reaches the CMOS switching level the latch is reset and the siren and bell is turned off. The alarm will then arm as if it were switched on again except that the prior entry LED will remain lit.

When the siren and bell circuit is triggered the transistors, Q1 and Q2, are turned on. Q2 then turns on Q3 which will activate a dc bell and will sink up to 1 A. Q1 enables the two LM555s which form the siren drive circuit. IC8 is configured as an astable which puts out a square wave signal. IC7 is used to modulate the frequency of IC8 by producing a low frequency sinusoidal type signal. The overall effect is to produce a piercing modulated siren type signal. This is then buffered by Q4 to provide the drive to run a 4 ohm speaker.

The board requires a nominal 12 V dc supply which is then filtered by C19 and C18. D1 provides protection against connecting the battery the wrong way round and ZD1 gives overvoltage protection.

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circuit will lock this out and only re-arm those sectors which are not active. This feature also means that if you wish to leave a window open at night but you still want to have the rest of the house protected you can simply turn on the alarm with the appropriate window open and the circuit will lock out that input.

To indicate the state of the alarm, seven LEDs are provided. A power on indication is given to show that dc power is being applied. At turn on, four red LEDs indicate whether each sector is sealed or unsealed. After a short time any unsealed sectors are locked out and the LEDs are extinguished. Once armed these same LEDs will indicate which sector was triggered if an alarm is sounded.

If the alarm is triggered then another LED will light to indicate that there has been prior entry. The remaining LED indicates that the exit delay is active. This display will allow you to easily determine the state of the alarm and see if it has been triggered.

The circuit also has an on board siren ▶

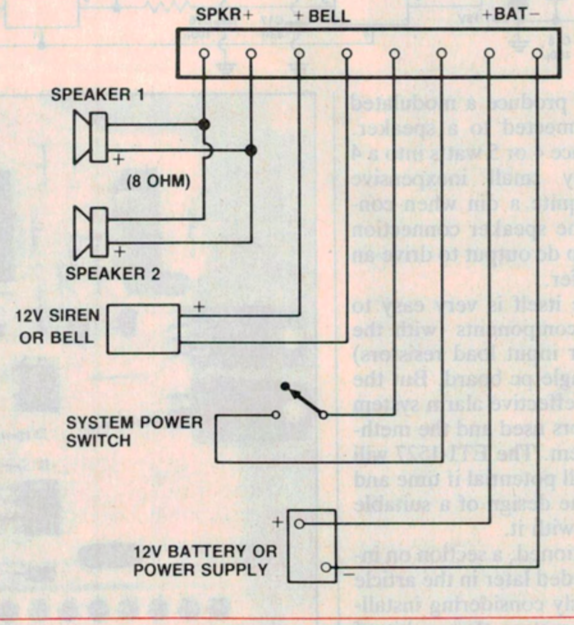
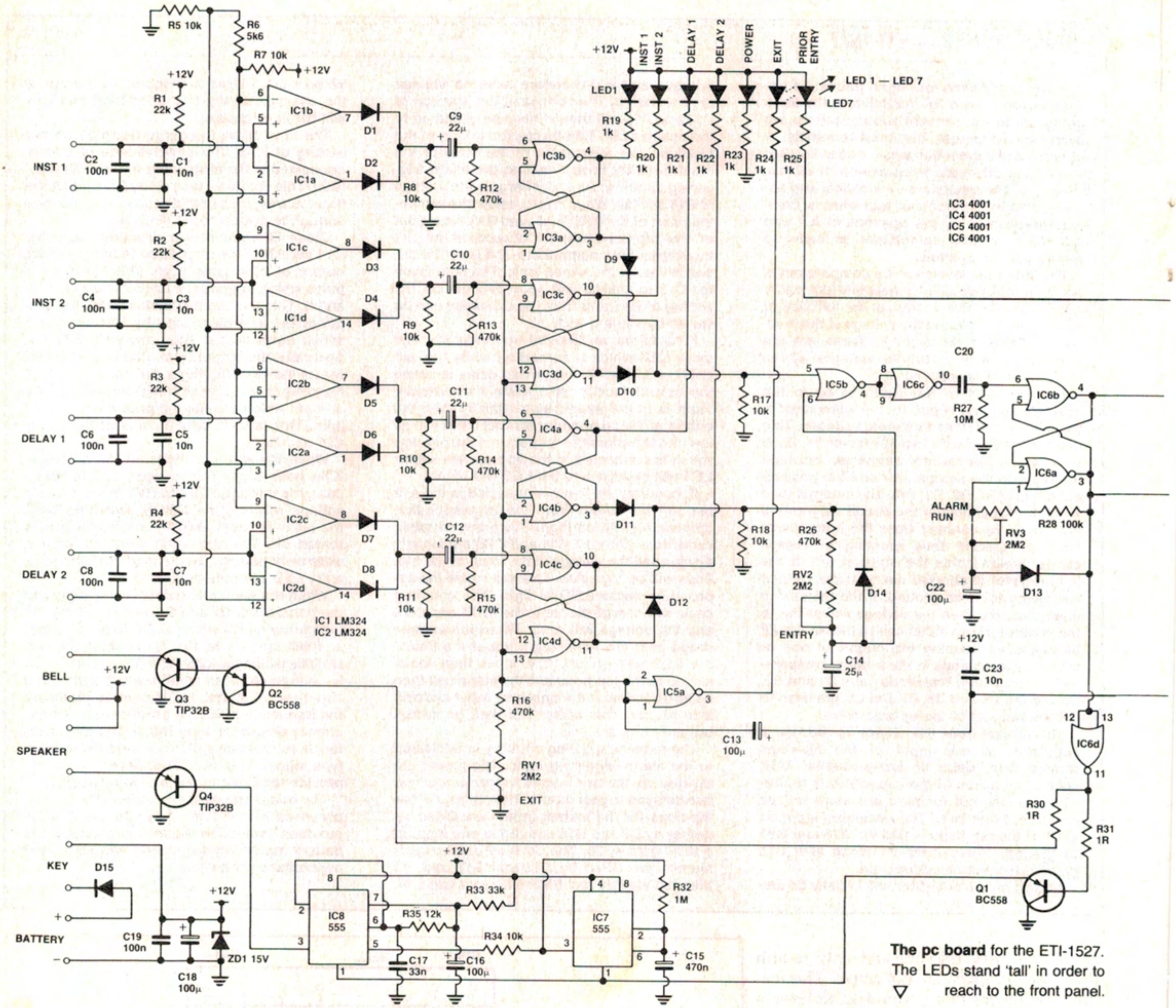


Figure 1. Wiring up the power supply and sirens to the module.

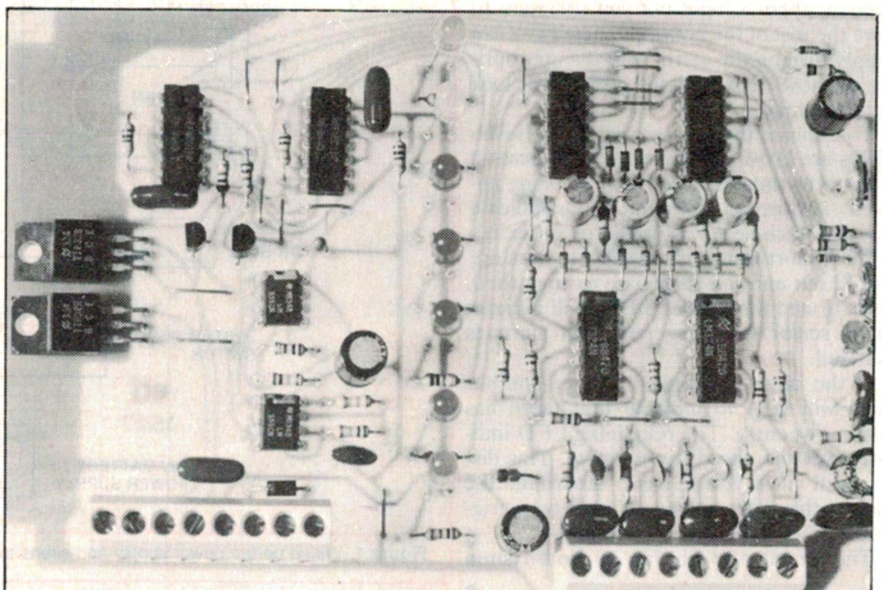


generator which will produce a modulated siren tone when connected to a speaker. The circuit will produce 4 or 5 watts into a 4 ohm load and any small inexpensive speaker will create quite a din when connected. As well as the speaker connection there is a 12 V, 1 amp dc output to drive an alarm bell if you prefer.

The alarm module itself is very easy to construct as all the components (with the exception of the four input load resistors) are mounted on a single pc board. But the key to a reliable and effective alarm system is the quality of sensors used and the methods used to install them. The ETI-1527 will only perform to its full potential if time and thought is put into the design of a suitable sensing system to go with it.

As previously mentioned, a section on installation will be included later in the article but if you are seriously considering installing your own alarm system then a bit of background reading wouldn't go astray.

The pc board for the ETI-1527. The LEDs stand 'tall' in order to reach to the front panel.



For a guide to components and kits for projects, see SHOPAROUND this issue.

PARTS LIST — ETI-1527

Resistors..................all ¼ W, 5%

R1, 2, 3, 4	22k
R5, 7, 8, 9, 10, 11, 17, 18, 34	10k
R6	5k6
R12, 13, 14, 15, 16, 26	470k
R19, 20, 21, 22, 23, 24, 25	1k
R27, 29	10M
R28	100k
R30, 31	1R
R32	1M
R33	33k
R35	12k
RV1, 2, 3	1M miniature trim.

Capacitors

C1, 3, 5, 7	10n ceramic
C2, 4, 6, 8, 19, 20	100n greencap
C9, 10, 11, 12, 14	22µ 16 V electro.
C13, 16, 18, 22	100µ 16 V electro.
C15	470n 16 V tag tantalum
C17	33n greencap
C21, 23	10n greencap

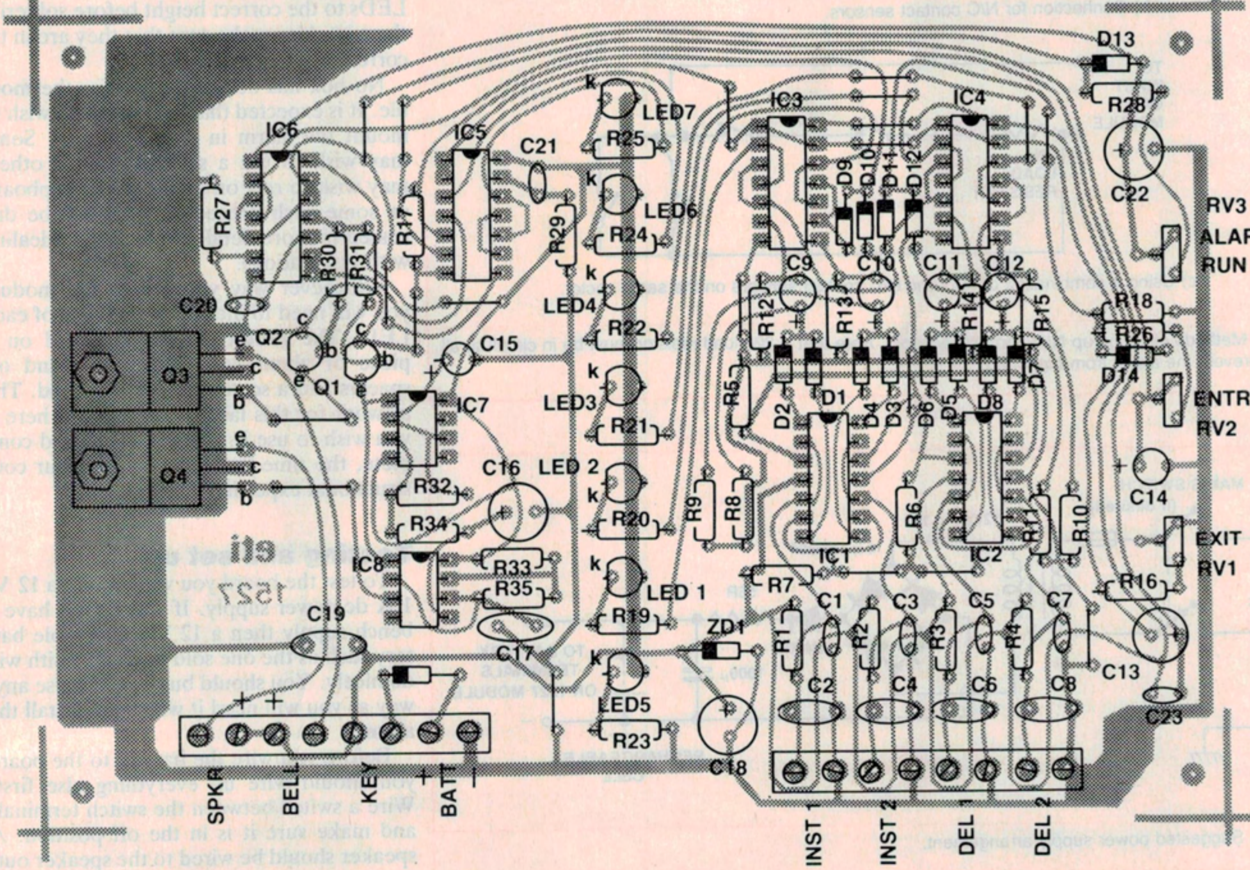
Semiconductors

IC1, 2	LM324
IC3, 4, 5, 6	4001B
IC7, 8	LM555
Q1, 2	BC558
Q3, 4	TIP32B
D1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14	1N914
D15	1N4004
ZD1	15V 400 mW zener
LED1, 2, 3, 4	5 mm red LED
LED5, 7	5 mm green LED
LED6	5 mm yellow LED

Miscellaneous

ETI-1527 pc board; ETI-1527 front panel (if required); 7 x 5 mm LED mounting grommets and washers; 300 mm tinned copper wire; 2 x ½" 6BA nuts and bolts; 2 x 8 way pc board mount terminal block.

Price estimate: $28-$30



The Australian Standards Association puts out a useful booklet called *A guide to the selection and application of intruder alarm systems*. This booklet can be obtained from the ASA and gives a good background to the types and uses of the various sensors available. The NRMA and other insurance companies may also be able to help you with information on security systems. For now, let's get on with the construction of the board.

Construction

Begin by carefully examining the pc board. Make sure there are no broken or shorted tracks. A magnifying glass is very handy for this. Once you are satisfied that the pc board is in good shape then you can start soldering in components. Start by soldering in the two eight-way terminal blocks. These should be located so that the connection clamp openings face the edge of the board.

Next you can locate and solder in the 20 wire links. These should be made with tinned copper wire. The resistors can then be soldered in followed by the capacitors. Take careful note of the polarity of all the electrolytics and the tantalum caps. These will only work if put in the right way round.

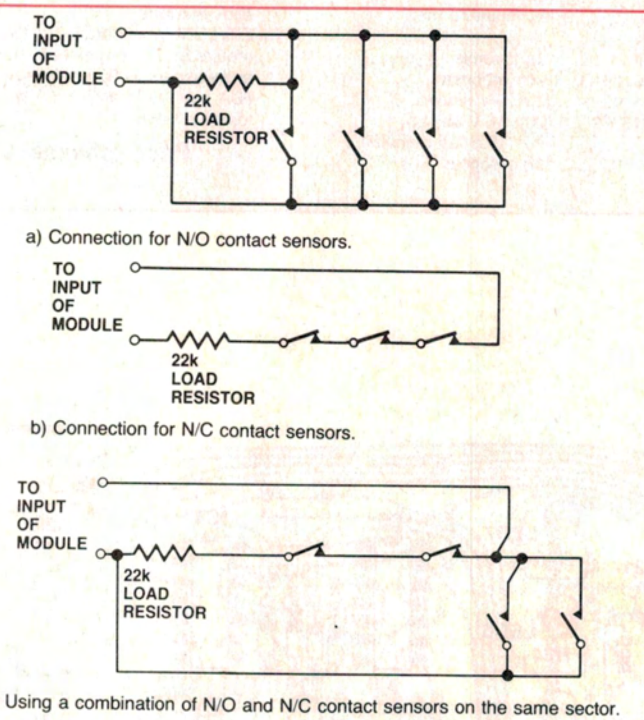


Figure 2. Methods of wiring up N/O and N/C sensors. Note that a 22k load resistor must be in circuit at all times to prevent the alarm from triggering.

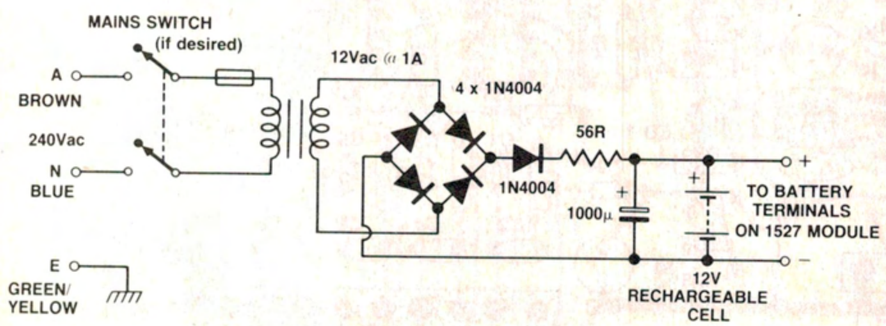


Figure 3. Suggested power supply arrangement.

Solder in the three miniature trimpots. The diodes can be put in next. These also need to be put in the correct way round so take careful note of the overlay diagram.

The rectifier diode and the Zener should not be confused with the 1N914 small signal diodes. The four transistors can be soldered in next.

The TIP32Bs need to be bent over to sit flat on the board. This should be done before they are soldered in to make sure that the holes line up. Bolt the TIP32Bs to the pc board securely. This is done for heatsinking reasons. The large copper area underneath them acts to dissipate any heat build up that may occur. If the board is going to be installed in an unventillated place then perhaps a bit of extra heatsinking could be provided.

The ICs should be soldered in next. If you wish to use sockets then do so, otherwise take special care to get all the ICs in the right way. Special care should be taken with the HEF4001Bs. These are CMOS devices and should be kept away from any static discharges. When soldering them in solder the ground pin (pin 7) and the power supply pin (pin 14) first.

The only remaining components to be soldered in are the LEDs. These should be left till last so that, if you intend to mount the board on a panel, you can adjust the LEDs to the correct height before soldering them in. Also make sure that they are in the correct way round.

No box has been specified for the module. It is expected that everyone will wish to mount the alarm in their own way. Some may wish to use a security box or others may wish to rely on hiding it in a cupboard or some such procedure (this will be discussed in more detail in the section dealing with installation).

Whichever way you mount the module you will need to mark the functions of each LED. The prototype was mounted on a piece of aluminium plate with stand off spacers and a scotchcal label attached. The artwork for this label is reproduced here if you wish to use it. With the pc board complete, the time has come to test your constructional expertise . . .

Testing and set up

To test the board you will require a 12 V, 1 A dc power supply. If you do not have a bench supply then a 12 V rechargable battery such as the one sold by Dick Smith will do nicely. You should buy one of these anyway as you will need it when you install the alarm.

Before you wire the battery to the board you should wire up everything else first. Wire a switch between the switch terminals and make sure it is in the off position. A speaker should be wired to the speaker output terminals in series with a 100 ohm resistor. The resistor will attenuate the volume of the siren so that you don't have the police arresting you for noise pollution.

All the trimpots should be set to minimum (fully counter-clockwise). The battery can now be connected. Make sure you connect it the right way round. OK! Brace yourself for any loud noises and/or smoke and flick the switch. If you are lucky the board will be still intact and all the LEDs except for the prior entry LED will be lit. The siren should not go off. If this is the state of affairs then so far so good.

After a few seconds the four red LEDs should got out. After about 30 seconds or so the yellow exit delay LED should go out leaving the power indicator as the only LED lit. If all this happens correctly then heave a sigh of relief and switch off.

Wire in 22k load resistors across each of the four input terminals. Make sure they are in securely and are not touching one another. Switch on again. This time only the power and exit delay LEDs should light. After the exit delay has expired the yellow LED should go out. The alarm is now in the armed state.

Short out the resistor on one of the instant inputs and leave it shorted. The siren should sound immediately and the appropriate red LED should light to show that that sector is unsealed. The green prior entry LED should also come on and stay on. After about 20 seconds or so the siren should stop and the alarm will re-arm itself as if it had just been switched on.

The sector LED should go out about five seconds after the siren has turned off. This indicates that the sector has been locked out. The other three sectors will be reactivated after the exit delay period has expired. The prior entry LED will stay on to indicate that the alarm has been triggered. It will only be reset when the alarm is turned off.

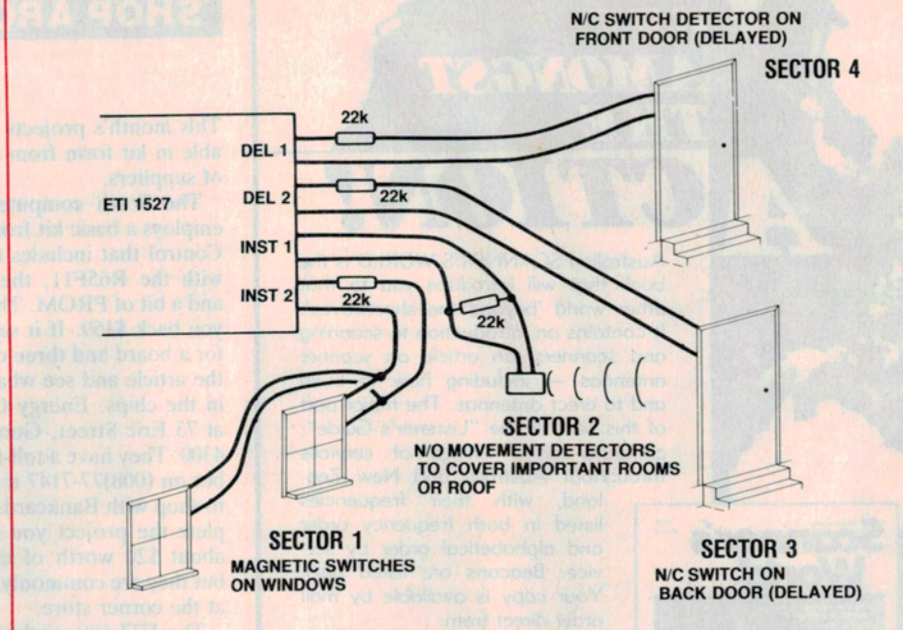


Figure 4. Typical application of the ETI-1527 module. Note that the entry and exit points are connected to the 'delay' inputs on the module.

The only thing left to do on the board is to set up the time delays. If you haven't yet decided where to install the module then you had better read the installation guide first and then come back to this section.

Firstly, get a watch with a second hand (or a digital watch if you would prefer a high tech approach!) and measure the time taken for you to leave the house from wherever the alarm will be situated. Also measure the time taken for you to open the front (or back) door and get to the alarm. The exit and entry delays can now be set to cover these measured times. Give yourself a fair bit of leeway as you may come in with your hands full one day and not be able to get to the alarm in time.

The alarm run time is a matter to decide yourself. It should be long enough to ensure that someone will be alerted but not long enough to annoy the neighbours too much if a false alarm occurs in the middle of the night. Once you have set the alarm up satisfactorily you can turn your attention to the problems of installation. Read the installation section thoroughly before buying or attempting to mount any sensors. ●

The installation section forms Part 2 next month.